Tissue Management Concepts

by Dan E. Fischer, DDS, FAGD

Educational objectives:
Upon completion of this course, participants should be able to achieve the following:
1. Differentiate between hemostasis and control of sulcular fluid or soft tissue.
2. Understand the procedure for active hemostasis and tissue displacement.
3. Understand restorative dentistry-based tissue management.
4. Understand barriers to successful tissue management.

Operative tissue management is one of the most important components of operative dentistry, including crown and bridge dentistry. Inadequate tissue management leads to poor impressions and poorly-fitting margins. The natural result, the ill-fitting restoration, can jeopardize the surrounding soft tissue and the adjacent tooth structure, complete with the eventuality of recurrent decay.

Historically, and even in contemporary dentistry, there are situations that require subgingival preparation of the margin. While cutting tooth structure, it is common to cut some soft tissue on the opposite side of the bur. Chemical mechanical packs have been a traditional method for displacing this tissue from the margins to create enough space for impression material and to attempt to address bleeding at the same time. However, trying to accomplish both of these objectives in one operation can be a challenge.
Hemostasis

In the past, buffered aluminum chloride was the standard for achieving hemostasis, but with mixed results. In researching a multitude of different chemistries to find an alternative, it soon became apparent that when using ferric sulfate, the sulfate ions would cause the blood to coagulate instantly. Clinically, this ferric sulfate formulation was superior for achieving active hemostasis. Ferric sulfate causes instant precipitation of blood protein while aluminum chloride works by another mechanism, which never precipitates blood proteins. Of note, even when blood is spun in a centrifuge and the solid cells and blood platelets are removed, ferric sulfate will precipitate the plasma with platelets present. Ferric sulfate functions with a mechanism independent of the normal clotting factors. This makes it also advantageous when controlling surface capillary bleeding for the hemophiliac and patents on blood thinners.

Traditional methods for achieving hemostasis have included packing a hemostatic-soaked cord into the sulcus. This method is ineffective when using ferric sulfate. The ferric sulfate solution in the cord will cause extravasated blood in the sulcus and potentially even in the capillary orifices to coagulate. However, upon removal of the cord from the sulcus, the coagulum tied to the cord pulls coagulum covering or even in the capillary orifices out with the cord and bleeding resumes. Ferric sulfate solutions are best delivered in a syringe with a specially designed tip (Metal Dento-Infusor tip, Ultradent Products, Inc.). This tip is not only used as an applicator, but also as a scrub brush. By pushing on the plunger and scrubbing with the tip, the ferric sulfate solution is moved within the cut capillary orifice while simultaneously scraping off extraneous coagulum at the cut tissue. The result is profound hemostasis achieved by the formation of the individual microscopic coagulum plugs within each capillary and with all extraneous coagulum wiped clean from the surface. This profound hemostasis is much different from the traditional passive hemostasis. With passive hemostasis, a little blood might seep from the tissues after the cord is removed, but there is a perception of control. Once the impression material is applied, (or the conditioning or adhesive applied in the case of the direct bonded restoration) often bleeding is again triggered. This lack of predictability is not practical in a clinical setting, making profound hemostasis preferable for operative procedures.

Tissue Displacement

Twisted or braided or retraction cords handle differently from a knitted cord (e.g., Ultrapak, Ultradent Products, Inc.; Packing Cord, Patterson Dental). Twisted cords have a tendency to separate upon packing. Braided cords do not separate, but are a little too rigid; when attempting to pack a braided cord down over an incline, it pops back up on the opposite end. A braided cord has fibers that run in the same direction along the long axis of the cord. A knitted cord’s fibers run in more of a cross sectional direction to the long axis due to the design of its interlocking. These loops have the ability to hold significant displacement and hemostatic fluid, while compressing nicely into the sulcus. However, this compression means that when using a knitted cord, it is necessary to use a size that appears larger than what would be required with a braided cord. Typically, a #2 knitted cord works well for molars, #1 for bicuspid, #1 or #0 for upper incisors, and #0 or #00 for lower incisors. For clinicians who prefer to leave a small cord in the sulcus while making the impression, the #000 cord is the tiniest knitted cotton cord in the world and works well in this double-cord technique. Soaking the retraction cord in the hemostatic solution prior to placement will allow for easier packing, but many clinicians are also successful in packing the cord dry and wetting it afterward.
Clinical Procedure

In the case used to illustrate the tissue management procedure, the clinician progressed through the following steps:

The materials are prepared, including attachment of a delivery tip (Metal Dento-Infusor) to a small syringe and loading the syringe with hemostatic (ViscoStat, Ultradent Products, Inc.). The clinician enters the bleeding sulcus with the syringe, circling the preparation: rubbing, scrubbing, and pressing firmly against the soft cut tissues while expressing material through the delivery tip (Figure 1). It is important to note that while it might seem counter-intuitive to rub a bleeding area in order to achieve hemostasis, scrubbing with appropriate firmness is crucial to the success of this procedure. Rubbing firmly inside of the cut capillary opening will scrub away excess coagulum, allowing the hemostatic agent to reach the cut tissue. A simple and gentle painting motion will leave a lot of coagulum and the bleeding will not stop. If/when the cord is removed and the tissue bleeds, it means that the hemostatic was not rubbed firmly enough before the cord was packed. After circling the preparation for 30-60 seconds, new coagulum ceases to form, indicating that the bleeding has stopped and the capillaries are sealed. A firm air/water spray and suction are used to clean the preparation and to act as a test; if the preparation bleeds from a firm water spray, it will also bleed the moment it is touched with impression material or, in the case of operative dentistry, the moment the adhesive applicator touches the tissue. If bleeding is reinitiated in the test, the clinician should reapply the hemostatic and follow with another firm spray, never moving forward with the procedure until profound hemostasis had been achieved. Note: If bleeding is not achieved within a reasonably short time, move to using Astringedent X. Albeit more acidic, it will more rapidly achieve hemostasis for the compromised tissues.

After the realization of profound hemostasis, tissue displacement occurs easily and cleanly as the cords are packed into the sulcus. In Figure 2, the retraction cord (Ultrapak) is soaked in the hemostatic (ViscoStat), then packed with a thin, serrated instrument (Fischer’s Ultrapak Packer, Ultradent Products, Inc.). The cord only remains in the sulcus for one or two minutes, since displacement is the only goal; some of the rubbery nature of the collagen was already eliminated through obtaining hemostasis with the applicator tip, so the tissues were conditioned not to spring back once the cord was removed. After achieving retraction, the cord is removed and the preparation is sprayed firmly with air and water. The clinician ensures that profound hemostasis is still in existence; washes, dries and makes the impression, always including a little bit of uncut tooth in the impression.

Hemostatic Acidity

All astringent type solutions, whether they are aluminum chloride (e.g. Hemodent, Premier Products Co.; Buffered Aluminum Chloride, Patterson Dental) or ferric sulfate solutions (e.g. Astringedent, ViscoStat) are acidic and within the 1 to 2 pH range.” This means they can literally etch dentin. Buffering can help reduce this but to significantly reduce it with buffering only causes the solution to reduce in effectiveness. However, by including ultra-small particle silica in the solution the hydronium ion (the acid ion formed by H+ plus H2O = H3O+) becomes loosely bound to the silica. Mineral astringents can be effective hemostatics but can be made kinder to mineralized tissues by combining them with fumed silica. Note: This is one reason that it is impossible to create an acid without water present. See in Figure 3 that decalcification has been prevented via this patented technology even with the smear plugs still in place after 12 to 15 minutes exposure. Additional effectiveness is gained as the applicator (Metal Dento-Infusor tip) rubs
against the cut tissues, even freeing up to some extent bound hydronium ion between the tip and the rubbed soft tissue.

**Interim Restorations**

It is important to pay attention to cut dentin to make sure that it is sealed. Published literature indicates that the exposed smear layer, left exposed for two days, is replaced by bacteria, with tubules opened and widened after one week. This is another important reason for making quality-fitting interims that seal. Interim restorations should seal all cut dentin to protect the 10,000-30,000 dentinal tubules contained underneath. One should either use immediate dentin sealing techniques and/or always use hydrophilic sealing provisional cements.

**Definitive Restorations**

After removing the interim restoration, the provisional cement must be scoured off the preparation to prepare for definitive cementation. Ideally, this cleaning should be performed with something that is more pure than pumice. Being derived from volcanic ash, pumice contains trace chemical impurities and ultra-fine particles that can even become lodged into tiny dentin crevaces. Consepsis Scrub (Ultradent Products) consists of high purity ground Pyrex glass with detergents that are safe to use with adhesives. After scouring, cleaning, washing and drying, it is not uncommon to note that margins are wet once again from sulcular fluid. The epithelium in the depth of the sulcus is only a couple of cells thick; the plasma-like fluid moves quickly through the tissue. It is impossible to perform quality, predictable dentin bonding in such an environment and attempting the procedure would result in microleakage. In the case of a total ceramic restoration, the stain would be visible as it moved between the preparation and tooth from the margins inward. To control the sulcular fluid prior to cementation or dentin bonding, gently rub the tissues with an astringent (i.e. aluminum chloride, alum, ferric sulfate). All astringents have the capability of stopping the permeability of the epithelium or the movement of fluid through the tissue. Then the conditioner and bonding agent can be applied in a controlled environment without contamination from sulcular fluid to the site. Note: If NOT using a phosphoric acid for conditioning, one should always scour once again the preparation surface prior to use of the “self etching/no-wash” conditioner and primer.

**Tissue Management for Adhesive Dentistry**

As important as quality tissue management is for crown and bridge dentistry, it is 10 times more important for adhesive dentistry. There are times when rubber dams are not practical and times when rubber dams can fail to prevent blood from moving and contaminating the field. In these cases, quality tissue management is imperative. Sulcular fluid can be detrimental to quality restorative dentistry. Whether it’s an adhesive, cementation or impression making procedure, the clinician must be in control, otherwise discoloration will result and the integrity of definitive restorations will be challenged.

Example: Four subgingival Class V bonded composites were placed on a retired pediatric dentist. A few weeks later, the patient reported that one of the restorations was turning black (Figure 4). This is symptomatic of contamination beneath the restoration. Though a hemostatic agent (ViscoStat) and retraction cord (Ultrapak) were used to control sulcular fluid on the four restorations, this was not the reason the restoration turned dark. Contrary to what some believe, ferric sulfate does not stain composite resins. However, most substance left between a preparation and the adhesive can be a contaminant; this includes hemostatics including ferric sulfate. This is why it is important to thoroughly rinse hemostatic agents away prior to pro-

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ceeding with the bonding procedure. The roof of the composite was removed, leaving a dark black stain showing through the translucent composite. Anaerobic bacteria live underneath leaky restorations and produce hydrogen sulfide gas. The gas combining with the ferric ions in the adjacent coagulum in the sulcus causes ferric sulfide to form and this black stain is evident. If using aluminum chloride, the stain is usually more of a bluish color. The real challenge is not the stain, but that the restoration leaked. Fortuitously, this stained so we could observe the leaking process prior to decalcification and caries in the dentin. During retreatment, control of the bleeding is crucial since the area is subgingival on a fairly broad, wraparound Class V restoration. The soaked cord is packed and followed with a firm air/water spray to remove all of the extraneous ferric sulfate or whatever hemostatic is being used; all hemostatics will act as contaminants if they are present between the tooth structure and the adhesive.

Effects on Impression Material

A thorough and firm air/water spray is extremely important prior to making impressions and prior to using adhesive materials. In addition, ferric sulfate will inhibit the polymerization of polyether impression materials if not thoroughly washed prior to impression making. If residual ferric sulfate remains on the preparation, unset polyether will be adjacent to the preparation upon removal of the polyether impression. It is also important to remember that the ferric sulfate solution will darken the tissues for 24-36 hours due to dark coagulum being present within the cut capillary openings. However, within that time period, it will leach out and the tissues will return to their natural color.

Immediate Dentin Sealing

Some new ideas and concepts have been introduced in the literature to address immediate dentin sealing or IDS. These concepts are relevant to the topic of tissue management since it is critical to achieve quality tissue management prior to application of dentin bonding agents.

When phosphoric acid comes into contact with tissues that are already under control, bleeding can sometimes be reinitiated. One reason for this is that phosphoric acid is an anti-coagulant, similar to the citric acid used to store blood in hospitals. Even self-etch acid materials that come into contact with tissues can trigger bleeding. It is important to give consideration to hemostasis, even with the design of self-priming bonding agents. After controlling bleeding, packing cord, and scrubbing the preparation (Consepsis Scrub), a new dentin bonding agent (Peak, Ultradent Products, Inc.) was used prior to making an impression. This dentin bonding agent keeps the acid and resin separate until it is activated by the clinician. The solution is therefore kept stable and enables a much higher bond strength than with traditional self-etch materials. The preparation should be rubbed for 10 seconds, air thinned, coated with a light-cured fill bonding agent and polymerized. So to assure there is no oxygen inhibition on the surface that can interfere with the polymerization of the impression material, PrimaDry (Ultradent Products, Inc.) can be applied and rinsed to dissolve/remove the oily layer. Alternatively, a 2x2 soaked with ethanol can be used to wipe the oily layer from the preparation. The light activation is preformed from the buccal, lingual and incisal to result in a very thin, very hard coating of resin and immediate dentin seal of the preparation. It is best to apply the dentin bonding agent just after obtaining control of the tissues but before making the impression. It is important to use a separating medium prior to fabricating the plastic provisional, or it will intimately cross link with the resin coating on the preparation, making removal impossible without cutting. Furthermore, a resin-based provisional cement should NOT be used for cementation of the provisional

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or the same problematic bonding will occur to the preparation. A hydrophilic cement such as UltraTemp will not bond facilitating normal removal when desired. Remove the extraneous cement. When the patient returns, cement the definitive. If using a conventional glass ionomer, resin-reinforced glass ionomer or a standard zinc phosphate, simply scour the preparation clean and then cement. If working with a total ceramic crown that necessitates a dentin bonding agent, we need to envision the desired result. We optimize the prior placed adhesive surface by following the scouring with the abrasive following with Peak SE or another self-etch. The adhesive is thinned, dried and followed with Peak SE for dual cure. It is placed on with just 1 or 2 micron thickness. This assures complete seating of the restoration.

There are times in restorative dentistry where rubber dams will not work and in those cases, there should always be a bite block in place. Imagine a rubber dam is in place for a deep Class II, but the matrix slid down the side of the preparation and around the tooth. By capillary action, the blood migrates up. It is important to remember that rubber dams are not hemostatics and that there is a need to control the bleeding prior to placing the rubber dam. Even when working supragingivally with a Class II, sulcular fluid can migrate onto the preparation margin when the matrix is slid down between the tooth and the rubber dam. Therefore, it is important to seal the tissues, controlling the bleeding or rubbing the non-bleeding sulcus to prevent sulcular fluid from entering the Class II preparation. Hemostasis and controlling fluids are paramount prior to cementation as well as during other operative procedures.

Sometimes aggressive bleeding can occur with patients who are hemophiliac, pregnant, taking Coumadin, or in unique cases such as when a patient has a broken, loose filling that has been shifting up and down each time the patient bites and for the last six months. Upon lifting the filling, it is obvious that the tissue is highly inflamed and the patient is bleeding profusely (Figure 5, page 60). In this case, a ferric subsulfate solution (Astringedent X, Ultradent Products, Inc.) is scrubbed into the bleeding area with the applicator tip to gain control. There is never an excuse for not controlling surface capillary bleeding.

It is important to remember that soft tissues will heal but leaky, poor fitting margins will never heal. Little capillary tubes were inserted into these canal openings (Figure 6, page 60). Since it would be virtually impossible to obtain a quality seal or even maintain a rubber dam clamp on these roots, the coronal aspects were reconstructed and polypropylene channels (from the capillary tips) were left in place to gain access for later root canal treatment (Figure 7, page 60). After the anatomy and contours were developed, the polypropylene tubes were removed; they slide out easily as the methacrylate based resins used in dentistry don’t adhere to polypropylene. During the root canal appointment, rubber dams were placed with ease and sealed as they should. The root canal treatment was able to be performed in an environment of quality bacterial control.

Control over fluids in the oral cavity – whether they be sulcular fluid, saliva or blood – is paramount to success in operative or crown and bridge dentistry. No contamination can be present in preparations through a bonding procedure. It is imperative that clinicians are in total control with tissue displaced appropriately for impression making. These guidelines help maximize the longevity of a restoration and are the responsibility of a quality professional; they help bring as much value as possible to the patients we serve “treating our patients as we would like to be treated.”

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Post-test

1. The phenomenon that best describes the mechanism for coagulation of blood by ferric sulfate is:
   a. Chemical cauterization
   b. Styptic action
   c. Hyper saturation
   d. Precipitation of blood protein

2. For the infusion technique of hemostasis, if one removes the cord and the tissues routinely bleed it means that:
   a. The cord was not soaked in the hemostatic prior to packing it
   b. The cord was not kept dry throughout the procedure
   c. The cord was not kept wet throughout the procedure
   d. The hemostatic was not rubbed firmly and adequately enough with the applicator tip before the cord was packed

3. Ferric sulfate can discolor
   a. Composite resin
   b. Soft tissues 24-36 hours post-op
   c. Porcelain
   d. Gold

4. Sulcular fluid can be predictably controlled prior to cementation or adhesive application by
   a. Good air drying
   b. Placement of a plain, dry cotton cord
   c. Application of an astringent such as alum, ferric sulfate or aluminum chloride
   d. Placement of a cord soaked in epinephrine

5. For immediate dentin sealing (IDS), it is best to apply the dentin bonding agent:
   a. With a 50:50 dilution in sterile water
   b. Just after obtaining control of the tissues (including blood and sulcular fluid), but before making the impression
   c. Immediately after making the impression
   d. Immediately upon completion of the preparation

6. When using knitted retraction cord, one should
   a. Use a size that is smaller than for a braided or twisted cord as it swells after packing
   b. Always use two cords as they will compress upon packing
   c. Use a cord that appears one size larger than with braided or twisted cords because knitted cords compress upon packing
   d. Always leave a small size cord in the depth of the sulcus

7. The Dento-Infusor should be used
   a. After careful and through dipping into the hemostatic solution
   b. Only on a syringe and with firm rubbing
   c. Only against tissues that have been reflected away from periostium
   d. Only with aluminum chloride solutions

8. Operative tissue management is
   a. Of minimal consequence for quality operative dentistry if the procedure is done quickly
   b. Pivotal to the success of not only quality impression making, but also for adhesive and cementation procedures
   c. Something to consider mostly for impressions
   d. The procedure of simultaneously irrigating and vacuuming as performed by the assistant to keep an area visible during a soft tissue operative procedure

9. Mineral astringents can be very effective hemostatics, but all
   a. Are very acidic so they should be buffered to render them safe to use
   b. Are acidic in nature but not of any significant degree
   c. Can be made much kinder to mineralized tissues by combining them with fumed silica
   d. Should only be used in an anhydrous solution so to prevent the harmful effects of low pH

10. Ferric sulfate can, unless rinsed adequately from the preparation, interfere with the set of
    a. Hydrocolloid
    b. PVS
    c. Polyether
    d. Addition silicone

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